Utilization of Dragon Fruit Peel as a Natural Gelling Agent

Abstract

This study examines the potential of dragon fruit peel as a natural gelling agent in pastry products, offering a sustainable alternative to conventional gelatin. The growing demand for plant-based ingredients in the food industry has prompted the search for innovative substitutes that align with consumer preferences for vegan and vegetarian options. Dragon fruit peel, known for its high pectin content, offers a solution to reduce food waste while providing an environmentally friendly gelling agent.

The research employed a pure experimental method conducted in a kitchen laboratory setting. Dragon fruit peel was processed into a gelling agent using blending and cooking techniques. The resulting agent was subjected to texture tests at two temperature conditions: room temperature (26°C) and chilled (6°C). The agent's performance was further evaluated with liquids, including milk and water, to assess its thickening capacity in pastry applications.

The findings indicate that dragon fruit peel exhibits effective gelling properties, producing a gel-like texture with stability when used in products such as Bavarois Cake, Mousse Cake, and Frozen Dragon Fruit Soufflé. However, in comparison to gelatin, it demonstrated a slower solidification rate at lower temperatures and some texture variations.

In conclusion, dragon fruit peel is a viable alternative to gelatin, particularly for consumers seeking plant-based options. Its ability to provide thickening and stabilizing effects, coupled with its sustainability benefits, makes it a promising innovation in the food industry. Further research is needed to optimize its solidification properties and expand its application in culinary products.

Keywords; *Dragon fruit peel, gelling agent, pectin based*

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Introduction

Innovation is a pivotal factor in the advancement of novel concepts, technologies, methodologies, and products within the culinary industry. This encompasses a range of domains, including menu formulation, culinary techniques, operational management, marketing, and the utilization of raw materials. One area of continuous innovation is the use of gelling agents, which are essential for producing food with a stable consistency, an appealing presentation, and positive consumer acceptance. As contemporary consumer preferences evolve, it is anticipated that the demand for products utilizing gelling agents will increase.

Hydrocolloids, a category of food additives, have been employed extensively in a diverse array of products due to their capacity to maintain consistency and texture. Their three-dimensional structure and behavior in solution have facilitated the production of high-quality food products. A contemporary examination of hydrocolloid development is vital for comprehending their function in food preparation and production.

One notable hydrocolloid is pectin, a pivotal component in gel formation present in many plants. Braconnot documented the first documented use of pectin in food preservation in 1825. Unlike other hydrocolloids, pectin is typically derived from natural waste materials rather than specially cultivated plants. This renders pectin a functional and sustainable alternative to gelatin.

The dragon fruit (pitaya), belonging to the cactus family, is cultivated in regions including Mexico, Central America, and parts of Asia, such as Indonesia (Winarsih, 2007). Dragon fruit is renowned for its high nutritional value, comprising vitamins C and B, calcium, fiber, phosphorus, and antioxidants. The peel of this fruit contains pectin, which can be employed to impart texture and consistency to food products (Susanto & Saneto, 1994). Furthermore, the utilization of dragon fruit peel can contribute to the reduction of environmental waste, thereby facilitating the implementation of more sustainable practices (Lusi Marlina et al., 2023).

This study examines the potential of dragon fruit peel as a plant-based gelling agent in mousse cake production. Gelling agents have been employed in the culinary arts for a considerable period, as evidenced by their use in a variety of foods, including cheese, custard, and yogurt (Myhrvold & Bilet, 2012). The advent of modern gelling agents has, however, broadened the range of culinary applications. Typically, gelatin is employed in the preparation of mousse cakes due to its stabilizing properties, which result in a smooth

texture and a melting sensation. Nevertheless, as gelatin is derived from animal collagen, it may not be appropriate for vegan or vegetarian consumers.

Dragon fruit peel represents a promising plant-based alternative due to its pectin content and bio-active compounds, including antioxidants. By repurposing the peel, the economic value of the fruit can be increased, thereby contributing to innovation in the culinary industry.

This research is an extension of previous studies that have employed gelatin in mousse cakes. In this study, dragon fruit peel was selected as the gelling agent, inspired by its gelatin-like consistency and pectin content. Following discussions with supervisors and lecturers, the decision was taken to test dragon fruit peel in a range of pastry products. The objective of this study is twofold: firstly, to develop a plant-based thickening agent that supports vegan and vegetarian diets, and secondly, to establish methods for using dragon fruit peel as a gelling agent. The study evaluates three pastry formulations in order to assess their taste, aroma, and texture and to determine whether dragon fruit peel can effectively substitute for gelatin in mousse cakes and other dessert applications.

Methodology

This study employed a pure experimental method conducted in a kitchen laboratory setting to evaluate the potential of dragon fruit peel as a gelling agent in pastry products. The experimental design was based on the scientific approach described by Sugiyono (2017), with the objective of identifying the effects of dragon fruit peel pectin on the texture and stability of the selected pastry items.

The experimental procedure was conducted in several stages. Initially, the dragon fruit peel was prepared. The peel was sorted, with the fins and core removed, then washed, blended, and strained to extract the pectin-rich juice. This extract was used directly or following a boiling process to reduce water content and concentrate the gelling agent. The extract was then mixed with liquid ingredients (water and milk) to assess its potential as a thickening agent in various pastry products.

Pastry Testing

A series of pastry products, including mousse cakes and frozen desserts, were prepared using dragon fruit peel extract as a substitute for gelatin. The efficacy of the gelling agent was assessed based on its capacity to maintain the structural integrity of the desserts, particularly in preventing melting in frozen products.

Research Setting

The experiments were conducted in the kitchen laboratory of Makassar Tourism Polytechnic, a higher education institution equipped with facilities for culinary experimentation. The laboratory provided the requisite tools and a controlled environment for the research. The dragon fruit peels were procured from the Pabaeng-baeng Market in Makassar and selected on the basis of the superior quality of the produce

available. The selection criteria included the assessment of freshness and moisture content, with the objective of ensuring the suitability of the peel for pectin extraction.

Data Collection

The data collection process involved the utilization of both primary and secondary sources. Primary data was obtained through direct experimentation and sensory evaluation, which was conducted using a structured questionnaire completed by respondents. As defined by Stone and Sidel (2004), sensory evaluation entails the assessment of products based on their visual, olfactory, gustatory, and tactile characteristics. Secondary data was gathered from relevant literature, including books, articles, and previous studies on gelling agents. The data mentioned above constituted a reference point, providing support and contextualisation for the present research's findings.

Data Analysis

The data was subjected to analysis in order to transform the raw data obtained from the experiments into meaningful insights. The experimental records and sensory evaluation results were subjected to analysis in order to ascertain the efficacy of dragon fruit peel as a gelling agent. This entailed a comparison of the texture, taste, and stability of the pastry products to ascertain whether dragon fruit peel could serve as an adequate replacement for traditional gelatin.

Results

Defining Stage

The objective of this stage was to ascertain the characteristics of the gelling agent produced from dragon fruit peels. To this end, a series of experiments were conducted. The objective of these experiments was to evaluate the potential of dragon fruit peel as a natural gelling agent as an alternative to gelatin in pastry products. The following section outlines the methodology employed in this experiment.

- The study employed 100 grams of red dragon fruit peel, utilizing solely the inner portion of the peel. The inner portion of the dragon fruit peel was selected for extraction to ensure the highest quality of the resulting product.
- Two methods were employed for the utilization of the gelling agent derived from dragon fruit skin. The initial method entailed the utilization of dragon fruit peels immediately following the blending process. In contrast, the subsequent method involved a cooking process, which was employed to enhance the gelling properties.
- A temperature test was conducted to evaluate the effects of temperature on the agent's properties. The gelling agent was evaluated at two distinct temperatures, room temperature (27°C) and chiller temperature (6°C), to assess its durability and viscosity under different storage conditions.

- Furthermore, the gelling agent was evaluated in conjunction with a variety of liquid ingredients, including water and milk, to ascertain alterations in texture and stability when employed in typical culinary applications.

The objective of these experiments was to ascertain the physical properties of the resulting gelling agent, including its durability at different temperatures and its compatibility with liquid materials. At this juncture, the objective was to ascertain the stability and texture of pastry products formulated with the dragon fruit peel gelling agent in comparison to the results obtained with the use of conventional gelatin. The findings of this pivotal phase demonstrated that the dragon fruit peel gelling agent possesses the capacity to preserve textural integrity at both cold and room temperatures. However, it was observed that modifications to the methodology were necessary to achieve uniform outcomes across diverse pastry products.

Development Stage

This subsection presents a comprehensive account of the data and research findings obtained during the development process, including detailed descriptions of the design stages, experimental trials (trial and error), and product testing. The following aspects are covered in the review:

- Materials and Equipment: The specific utensils and equipment employed in the study are outlined.
- Gelling Agent Preparation: The process of preparing the gelling agent is detailed.
- Evaluation of Applications: The research team evaluated the dragon fruit peel gelling agent in various applications.
- Evaluation in Pastry Products: A specific evaluation of the gelling agent in pastry products is provided.

First Stage

Figure 1. The process involved the preparation of the gelling agent (Source: Research Data)

The initial stage of the process involved the preparation of the gelling agent, which was carried out as follows:

- Preparation of Dragon Fruit Peel:
  - 100 grams of red dragon fruit peel were utilized, focusing on the inner portion of the peel.

- The dragon fruit peel was meticulously cleaned and washed prior to processing. The outer skin was removed, as it had a detrimental impact on the texture quality of the gelling agent.
- For efficiency, the inner peel of the dragon fruit was blended using a hand blender. The gelling agent produced from this blending process was ready to be used in pastry products.

Second Stage

Figure 2. Temperature measurement of the dragon fruit peel gelling agent after processing (Source: Research Data)

The process continued with the application of several experimental methods.

- First Experiment:

  The gelling agent was stored at room temperature (26°C). Observations indicated no alteration in texture or consistency. The consistency remained stable, leading the researchers to conclude that this gelling agent is suitable for use as an alternative thickening agent in pastry products stored at room temperature.
- Second Experiment:
  - The gelling agent was stored in a refrigerated environment at 6°C. Results showed that changes in texture were dependent on storage duration.
  - After 10 minutes, the gelling agent exhibited slight thickening and setting properties, though it did not attain complete solidification. Upon inverting the container, the gelling agent showed a gradual descent.

Figure 3. Following 10 minutes, the gelling agent exhibited indications of slight thickening (Source: Research Data).

  - After 20 minutes, the texture became thicker and more solidified, and no leakage occurred when the container was inverted.

Figure 4. Following 20 minutes, the gelling agent exhibited signs of solidification (Source: Research Data).

- After 30 minutes, The gelling agent became markedly thicker and more dense, though not as firm as gelatin or agar-agar. It remained stable when inverted.

Figure 5. Following 30 minutes, the gelling agent exhibited enhanced thickness and stability (Source: Research Data)

- Third Experiment:

  The gelling agent was combined with liquids, including water and milk (100 ml of milk and 30 grams of gelling agent). Results demonstrated that the milk attained a consistency comparable to that achieved through mixing gelatin with water. This was attributed to the pectin content in the dragon fruit peel, which imparted a thickening effect.

Figure 6. A gelling agent mixed with water and milk shows a thickening effect (Source: Research Data).

Discussion

One of the most noteworthy characteristics observed was the gel-like texture produced by this gelling agent. The texture is formed due to the pectin content, which is estimated to be approximately 10.8%

(Yati et al., 2017). Although this texture resembles gelatin, there are notable differences in consistency, particularly at low temperatures, such as those found in refrigerated conditions. Pectin with a degree of methoxylation (DM) below 60% exhibits slower thickening and is effective in systems with high sugar content. Pectin with DM below 50% is able to gel in calcium-containing solutions, which contributes to viscosity when mixed with milk.

The utilization of a gelling agent derived from dragon fruit peel in a range of pastry products, including Bavarois Cake, Mousses Cake, and Frozen Dragon Fruit Soufflé, demonstrated that this ingredient could serve as a viable alternative to gelatine. The results of the texture evaluation showed that the pastry products containing this gelling agent exhibited a thickness and softness that were nearly comparable to those prepared with gelatin. However, notable discrepancies were observed, particularly with regard to the freezing process and texture structure. This suggests that the gelling agent derived from dragon fruit peel is effective, although some modifications may be necessary to optimize the product.

In addition, the pink color in the product produced from this gelling agent comes from the betacyanin compound found in dragon fruit peel. This color gives the final product a good visual appeal. The flavor and aroma of the gelling agent did not have a major influence on the final product, in accordance with previous studies that mentioned that pectin does not provide a strong flavor or aroma, so it does not distort the original characteristics of the pastry products produced.

The findings of this study are also consistent with the existing literature on the role of pectin and gelatin in texture formation and their use in pastry products. Pectin with low dry matter (DM) exhibits comparable functions to gelatine, although it displays distinctive characteristics in terms of drying time and consistency. The findings of this study support the hypothesis that pectin can be an effective substitute for gelatin in pastry products. This conclusion is consistent with the scientific guidelines that recommend the use of pectin for thickening formulations in specific systems.

The study makes a significant contribution to the field of culinary science, particularly with regard to the utilization of natural and locally sourced ingredients, such as dragon fruit peel, as an environmentally friendly alternative to gelatine. This is consistent with the principles of sustainability in food product development, which not only emphasizes the use of natural ingredients but also seeks to reduce dependence on imported ingredients. The utilization of dragon fruit peel as an environmentally friendly gelling agent has the potential to facilitate novel developments within the contemporary culinary industry, particularly for those adhering to a vegan or vegetarian diet. Therefore, this research not only substantiates the potential of dragon fruit peel as a thickening agent but also offers a broader scope for innovation in the development of sustainable food products.

Conclusion

This study underscores the potential of dragon fruit peel as a natural, plant-based gelling agent for pastry products, offering a sustainable alternative to gelatin. The peel contains approximately 10.8% pectin, which produces a gel-like texture that effectively thickens and stabilizes a variety of products, including Bavarois cake, mousse cake, and frozen dragon fruit soufflé. The natural pink hue derived from betacyanin not only enhances the visual appeal of the final product but also preserves the flavor profile of the original ingredient. However, the slower solidification rate, particularly in cooler environments, indicates the need for further optimization to improve its consistency and performance across diverse applications. Despite these limitations, dragon fruit peel shows significant potential as an environmentally friendly alternative, supporting the growing demand for sustainable and plant-based ingredients. Future research should focus on refining its gelling properties and exploring broader applications in the food industry to unlock its value as a full substitute for conventional gelatin.

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